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Weight Loss and Dietary Intake After Vertical Banded Gastroplasty and Roux-en-Y Gastric Bypass

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Objective

The purpose of this study was to learn whether preoperative eating habits can be used to predict outcome after vertical banded gastroplasty (VBG) and Roux-en-Y gastric bypass (RYGB).

Background Summary

Several independent randomized and sequential studies have reported significantly greater weight loss after RYGB in comparison with VBG. Although the mechanism responsible for weight loss after both procedures is restriction of intake rather than malabsorption, the relationships between calorie intake, food preferences, and postoperative weight loss are not well defined.

Methods

During the past 5 years, 138 patients were prospectively selected for either VBG or RYGB, based on their preoperative eating habits. All patients were screened by a dietitian who determined total calorie intake and diet composition before recommending VBG or RYGB. Thirty patients were selected for VBG; the remaining 108 patients were classified as "sweets eaters" or "snackers" and had RYGB. Detailed recall diet histories also were performed at each postoperative visit.

Results

Early morbidity rate was zero after VBG *versus* 3% after RYGB. There were no deaths. Mean follow-up was 39 ± 11 months after VBG and 38 ± 14 months after RYGB. Mean weight loss peaked at 74 ± 23 lb at 12 months after VBG and 99 ± 24 lb at 16 months after RYGB ($p \leq 0.001$). Twelve of 30 VBG patients lost ≥50% of their excess weight *versus* 100 of 108 RYGB patients ($p \leq 0.0001$). Milk/ice cream intake was significantly greater postoperatively in patients who underwent VBG *versus* patients who underwent RYGB after 6 months ($p \leq 0.003$), whereas solid sweets intake was significantly greater after VBG during the first 18 months postoperatively ($p \leq 0.004$). Revision of VBG was performed in 6 of 30 patients (20%) for complications or poor weight loss, whereas only 2 of 108 patients who underwent RYGB required surgical revisions ($p \leq 0.001$).

Conclusions

These data show that VBG adversely alters postoperative eating behavior toward soft, high-calorie foods, resulting in problematic postoperative weight loss. Conversely, RYGB patients had significantly greater weight loss despite inferior preoperative eating habits. The high rate of surgical revision in conjunction with inconsistent postoperative weight loss has led us to no longer recommend VBG as treatment for morbid obesity.

A number of randomized and sequential comparative studies have shown that gastric bypass consistently produces greater weight loss than any of several modifications of stapled gastroplasty.[1-7] The anatomic similarities between gastroplasty and gastric bypass suggest that the consistently superior weight loss produced by gastric bypass may be caused by factors other than mechanical gastric restriction. Fat malabsorption, dumping syndrome, and changes in taste preference for specific foods all have been suggested as reasons for the superior weight loss observed after gastric bypass.[3-5,8] Sugerman and associates recently attributed the inconsistent weight loss observed after vertical banded gastroplasty (VBG) to abuse of sweets in preference to other more nutritious solid foods.[5] Sugerman's group concluded that analysis of patients' preoperative eating habits can be used to maximize postoperative weight loss after VBG. However, there are no prospective studies that have carefully evaluated the impact of both preoperative and postoperative dietary intake on outcome of bariatric operations. The present prospective study was undertaken to determine whether assessment of preoperative eating patterns and food preferences can be used to predict weight loss outcome after VBG and Roux-en-Y gastric bypass (RYGB).

MATERIALS AND METHODS

Patient Selection Criteria

Between 1986 and 1990, 138 patients were evaluated as candidates for either VBG or RYGB. All but one patient was at least 100 pounds above ideal weight, as determined by the 1983 Metropolitan Life Insurance Tables,[9] and all had failed multiple serious attempts at nonoperative weight reduction. Super obese patients who were more than 200 pounds overweight were excluded from this study. At the initial preoperative visit, the nutritionist (HK or LR) obtained a detailed diet history, which included a 1-day dietary recall. The typicality of the 1-day recall was established further by questioning how often during a typical week that the 1-day diet pattern was repeated. Portion sizes were estimated by showing candidates premeasured cups and plastic food models of specific weights in grams. The interview also included detailed questions regarding intake of the following food items: 1) liquids, including alcoholic beverages, 2) ice cream, 3) sweets and desserts, 4) salty snack foods, 5) fried or fast foods, 6) pizza, and 7) binges. Binges were defined as consumption of particular foods in greater than usual amounts. The same methodology was employed in collecting dietary information at each postoperative follow-up visit.

At the conclusion of the preoperative screening interview, the surgeon (RB) and dietitian reviewed the diet history and recommended either VBG or RYGB. Patients who ate large quantities of typical mealtime food at regular intervals were recommended for VBG. The remaining patients were considered either "sweets eaters" or "snackers" and were advised to have RYGB. Snacks were defined as between-meal or after-dinner food contacts of ≥150 calories each. A sweets eater was defined by three or more weekly between-meal contacts of at least 150 calories per contact with sweet liquids or solids, whereas an ice cream eater was defined by consumption of two or more servings per week.

Vertical banded gastroplasty and RYGB were performed by one surgeon at Robert Wood Johnson University Hospital. The technique used for RYGB illustrated in Figure 1 has been described in detail elsewhere.[10,11] The technique used for VBG shown in Figure 2 followed Mason's early recommendations,[12] except that the circumference of the Marlex—band was precisely measured after placement around the stoma. With this modification, the measured external stomal circumference ranged from 4.3 to 5.0 cm among the 30 patients who underwent VBG. A limited barium upper gastrointestinal contrast study was performed for each patient before discharge to examine the integrity of the stapleline and stoma.

At discharge, patients were instructed to follow a maximum 1000 calorie modified liquid diet for approximately 4 weeks.[8] After 4 weeks, the modified liquid diet was advanced to a soft solid diet. Subsequent follow-up visits were scheduled at 3-month intervals for the remainder of the first year, at 6-month intervals during the second year, and annually thereafter. All patients were queried about postprandial emesis. These data were recorded as the number of vomiting episodes per week. Most patients accomplished the transition from soft food to pulpy fruits, vegetables, and lean meat within the first 6 months. Nearly all patients who underwent RYGB were able to eat small portions of all types of solid food by 8 or 9 months postoperatively. Conversely, many pa-

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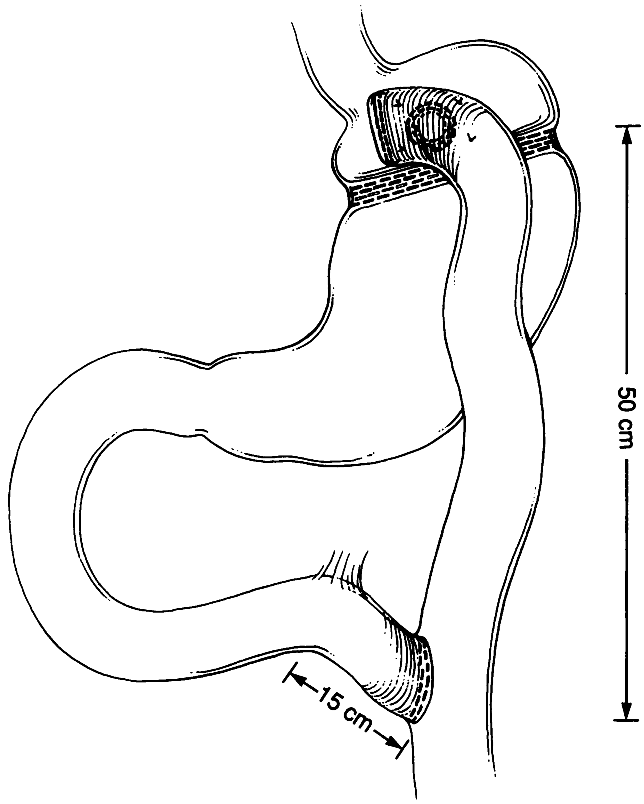

Figure 1. Roux-en-Y gastric bypass in which the TA 90-B®—stapler (U.S. Surgical Corp., Norwalk, CT) was fired horizontally, creating a 25 ± 5-mL upper pouch. The jejunum was divided 15 cm distal to the ligament of Treitz with the distal end anastomosed to the upper stomach using a 21-ILP®—circular stapler (Ethicon Inc., Somerville, NJ) creating an 11.4-mm diameter anastomosis. The proximal end of jejunum was then anastomosed 50 cm below the gastrojejunostomy. Reproduced with permission of Mosby Yearbook, Inc.

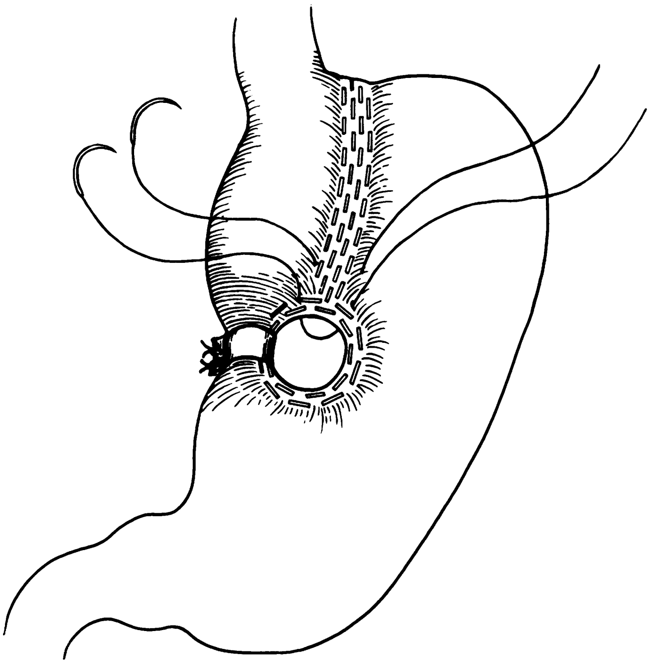

Figure 2. Vertical banded gastroplasty in which the stomach is partitioned using the TA 90-B®—stapler creating a 20 ± 5-mL upper gastric pouch. The stoma is created by firing the #28 EEA stapler (U.S. Surgical Corp.) adjacent to a 30-Fr diameter bougie. Two interrupted 2-0 silk sutures were placed approximately 1.0 cm apart at the intersection of the stoma and the vertical staple line to prevent the staples from pulling out.

tients who underwent VBG could never comfortably consume lean meat at any time postoperatively.

Patients' age, sex, preoperative weight, and body mass index are shown in Table 1. There were no significant differences in these demographic variables between the two groups. Although the mean weight of patients who underwent RYGB was somewhat greater in comparison with the patients who had VBG, the body mass index of each group was almost identical. Before operation, there were 32 medical problems recognized in 23 patients who had VBG and 146 medical problems identified in 72 RYGB patients, as shown in Table 2. Seven patients who underwent VBG (23%) and 34 patients who underwent RYGB (31%) did not have concomitant medical illnesses preoperatively.

Analysis of Dietary Data

The eight dietary variables that were evaluated during the study are shown in Table 3. The 1-day recall diets were analyzed at 6-month intervals by a computer program (Nutritionist III, N-Squared Computing, Silverton, OR). To determine the percentage of calories in the diet that were derived from sweet-tasting solids and liquids and from milk products, the computer program classified food items into the following two categories: 1) sweets/soda (SWS), which included sweet solids, such as candy and pastries, and sweet-tasting beverages, such as soda and juices; and 2) milk and ice cream products (MIC). To evaluate the percentage of sugar in the diet that was derived from liquids *versus* solids, all SWS items were divided into the following two categories: 1) sweet-tasting high calorie liquids (HCL) and 2) nonliquid sweets (NLS). The caloric content of individual items in the SWS, MIC, HCL, and NLS categories were combined manually to obtain the total calories in each category. Alcohol was not included in either the SWS or HCL category because very few patients consumed alcoholic beverages. Moreover, alcohol abuse was reason for rejection of patients as candidates for either operation.

Numeric data are expressed as the mean plus/minus the standard deviation. Statistical analysis was performed with the Statistical Analysis System using the chi square test, a one-way analysis of variance with repeated measures, Duncan's multiple range test, unpaired Student's t test, and the Wilcoxon rank sum test.

Table 1. PREOPERATIVE DEMOGRAPHIC DATA

Operation	No. of Patients	Male	Female	Age (yrs)	Weight (lbs)	BMI (kg/m^2)
VBG	30	6	24	39 ± 9	252 ± 39	42 ± 4
RYGB	108	15	93	38 ± 10	266 ± 48	43 ± 4

RESULTS

Nutrition and Weight Loss Data

Preoperative nutrient intake as determined by the 24-hr recall diet histories is shown in Table 4. Preoperative calorie intake was greater in patients who underwent VBG at a level that approached significance ($p \leq 0.06$ by unpaired Student's t test). Protein intake was similar in the two groups. However, daily carbohydrate intake was significantly greater in patients who underwent RYGB, whereas fat intake was proportionately greater in patients who underwent VBG. Although SWS intake was significantly greater in patients who had RYGB, the difference in preoperative NLS and HCL consumption between the two groups was not significant.

Weight loss is shown in Figure 3. Weight loss at 6 months was similar in the two groups. However, beginning at 12 months postoperatively, weight loss was significantly greater in those who underwent RYGB *versus* patients who underwent VBG ($p \leq 0.005$ by Wilcoxon rank sum test). Mean weight loss peaked at 74 ± 23 lb at 12 months after VBG *versus* 99 ± 24 lb at 16 months after RYGB ($p \leq 0.001$ by unpaired Student's t test). This loss corresponded to loss of 53% of the excess weight in patients who underwent VBG and 72% of the excess weight in patients who underwent RYGB. However, only 12 of 30 (40%) patients who underwent VBG lost ≥ 50% of their excess weight, whereas 100 of 108 (92%) patients who underwent RYGB lost this much weight ($p \leq 0.0001$ by chi square test).

Follow-up ranged from 6 to 68 months after VBG, mean = 39 ± 11 months, and from 6 to 76 months after RYGB, mean = 38 ± 14 months. One patient who had VBG and 4 patients who had RYGB were unable to be

Table 2. OBESITY-RELATED MEDICAL PROBLEMS INCIDENCE AND RESPONSE TO WEIGHT LOSS

Problem	No. (%)	Resolved	Improved	Unchanged
Hypertension				
RYGB	43 (40%)*	21	18	1
VBG	11 (37%)	2	3	6
Hyperlipidemia				
RYGB	43 (40%)*	29	12	1
VBG	8 (27%)	2	3	3
Arthritis				
RYGB	34 (31%)*	9	21	2
VBG	9 (30%)	0	5	3
Diabetes				
RYGB	9 (8%)*	6	2	0
VBG	1 (3%)	1	0	0
Asthmatic bronchitis				
RYBG	8 (7%)	3	4	1
VBG	1 (3%)	0	1	0
Angina/CHF				
RYGB	4 (4%)	1	3	0
VBG	0 (0%)			
Venous stasis				
RYGB	3 (3%)	1	1	1
VBG	1 (3%)	0	1	0
Sleep apnea				
RYGB	2 (2%)	2	0	0
VBG	1 (3%)	1	0	0
Total				
RYGB	146	72 (52%)	61 (44%)	6 (4%)
VBG	32	5 (16%)	16 (50%)	11 (34%)

RYGB = Roux-en-Y gastric bypass; VBG = vertical banded gastroplasty.
Numbers in parentheses in second column represent the percentage of the entire series of 108 RYGB nd 30 VBG patients.
* One or more patients were unavailable for follow-up of medical problem at ≥12 mo. postoperatively.
Medical problems were considered resolved when controlled without the need for medications and improved when controlled on reduced doses of medication. A significantly greater number of RYGB patients had improvement or resolution of coexisting medical problems *vs.* VBG patients ($p < 0.001$ by chi square test).

Table 3. DIETARY VARIABLES

Total calorie intake
Protein
Carbohydrate (CHO)
Fat
Solid sweets and high calorie beverages (SWS)
Milk or ice cream products (MIC)
High calorie liquids (HCL)
Nonliquid sweets (NLS)

Protein, carbohydrate, fat, SWS and MIC intake are expressed as a percentage of the total daily calorie intake. HCL and NLS were calculated and expressed as a percentage of daily dietary sugar intake.

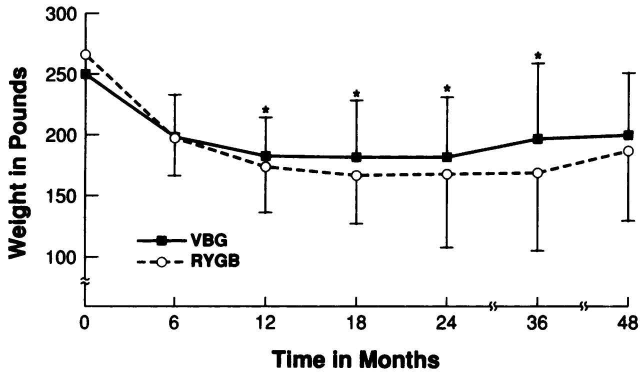

Figure 3. Mean weight after Roux-en-Y gastric bypass and vertical banded gastroplasty. *Indicates significant difference in weight loss between operations at specified postoperative time intervals ($p \leq 0.005$ by Wilcoxon rank sum test). Bars indicate one standard deviation.

observed for follow-up during the first 12 months. Overall, three patients who underwent VBG (10%) and 12 patients who underwent RYGB (11%) were unable to be observed for follow-up during the 5-year study period. However, a number of patients missed one or more interval visits, but they were able to be observed for follow-up.

Postoperative calorie, protein, carbohydrate, and fat intake are shown in Table 5. The lowest calorie intake occurred at 6 months after both procedures. Although calorie intake after RYGB was consistently lower in comparison with VBG at each postoperative interval, the differences were not significant because of variance among individual patients. The disparity in calorie intake between the two operations persisted in patients who were evaluated at more than 36 months postoperatively. Consumption of protein, carbohydrate, and fat remained relatively constant over time after both operations. However, mean carbohydrate intake at 12 months after VBG was significantly decreased *versus* RYGB levels. Conversely, fat intake after VBG was significantly greater *versus* RYGB levels at 12 months postoperatively. Postoperative fat intake was decreased significantly *versus* preoperative levels at 6, 18, 24, and 36 months after VBG and at 6 and 36 months after RYGB. Mean protein intake in patients who underwent VBG was significantly less *versus* patients who underwent RYGB at 36 months postoperatively.

Table 4. PREOPERATIVE NUTRIENT INTAKE

Nutrient	VBG	RYGB
Calories	3120 ± 1168	2604 ± 1087
Protein	17 ± 3%	18 ± 6%
CHO	40 ± 15%*	46 ± 9%*
Fat	46 ± 7%*	36 ± 8%*
SWS	17 ± 10%*	26 ± 17%*
MIC	9 ± 7%	9 ± 9%
NLS	2 ± 18%	23 ± 27%
HCL	30 ± 29%	26 ± 33%

VBG = vertical banded gastroplasty; RYGB = Roux-en-Y gastric bypass; CHO = carbohydrate; SWS = sweets/soda; MIC = milk and ice cream products; NLS = non-liquid sweets; HCL = high calorie liquids.

Data expressed as mean ± SD * indicates a significant difference between operations ($p \leq 0.001$ by unpaired Students t test).

Postoperative changes in SWS intake and MIC product intake are shown in Table 6. Postoperative consumption of SWS was similar in both groups, whereas intake of MIC was significantly less after RYGB *versus* VBG at all postoperative intervals. After RYGB, consumption of SWS and MIC was significantly decreased *versus* preoperative intake during the first 24 months postoperatively. Conversely, there was no difference in preoperative *versus* postoperative consumption of SWS and MIC in VBG patients.

Consumption of HCL and NLS are presented in Table 7. Intake of HCL after RYGB was reduced significantly *versus* VBG levels at 6 and 12 months postoperatively. Although NLS intake increased gradually after both operations, NLS consumption in patients who underwent RYGB was significantly less in comparison with patients who underwent VBG during the first 18 months postoperatively. After RYGB, intake of HCL was decreased significantly *versus* preoperative levels at 12, 18, and 24 months, whereas intake of NLS was significantly less than preoperative intake at all postoperative intervals. Conversely, HCL intake at 6 months after VBG was significantly greater than preoperative intake.

A post hoc comparison of the number of meals and snacks consumed by the two groups was performed to confirm appropriate selection of patients for VBG *versus* RYGB. Patients who underwent VBG ate a mean 2.5 ± 1.0 meals and 1.1 ± 0.9 snacks per day *versus* an average of 2.4 ± 0.8 meals and 1.6 ± 0.9 snacks consumed by the group that underwent RYGB. The difference in the number of daily snacks was significant ($p \leq 0.01$ by Wilcoxon rank sum test).

Postoperative Complications

There were no early postoperative complications after VBG and three early complications after RYGB, including two cases of pulmonary embolism and one subhepatic abscess. The subhepatic abscess was treated successfully by percutaneous catheter drainage. In one patient who underwent VBG, a tiny staple-line disruption was noted on the upper gastrointestinal contrast study that

Table 5. POSTOPERATIVE CALORIE, PROTEIN, CARBOHYDRATE, AND FAT INTAKE

	Calories		Protein		Carbohydrate		Fat	
Time (mo)	VBG	RYGB	VBG	RYGB	VBG	RYGB	VBG	RYGB
6	1161 ± 621†	890 ± 407†	18 ± 8	20 ± 7	47 ± 15	48 ± 11	36 ± 13*†	31 ± 11*†
12	1310 ± 589†	1116 ± 426†	17 ± 6	19 ± 6	39 ± 11*	47 ± 12*	40 ± 10*	34 ± 11*
18	1387 ± 587†	1256 ± 504†	19 ± 6	19 ± 5	43 ± 11	46 ± 12	36 ± 12†	35 ± 12
24	1494 ± 769†	1319 ± 912†	17 ± 4	20 ± 7	45 ± 11	45 ± 13	38 ± 11†	34 ± 11
36	1753 ± 1043†	1386 ± 578†	14 ± 4*	18 ± 6*	48 ± 10	50 ± 9†	34 ± 11†	33 ± 8†

VBG = vertical banded gastroplasty; RYGB = Roux-en-Y gastric bypass.
Data expressed as mean ± SD of the percentage of daily calorie intake of protein, carbohydrate (CHO) and fat.
* Significant difference between operations ($p \leq 0.05$ by Wilcoxon rank sum test).
† Significant difference between preoperative and postoperative intake ($p < 0.05$ by ANOVA with Duncan multiple range test).

was performed before discharge. However, this problem did not result in either unsatisfactory weight loss or other complications. There were no postoperative wound infections or deaths in either group.

There were eight late complications after VBG (27%). Two patients who underwent VBG developed incisional hernias. Six patients (20%) developed stomal stenosis between 6 and 24 months postoperatively. Two of these six patients were treated successfully by endoscopic balloon dilatation. The remaining four required surgical revision after failure of conservative treatment. Two other patients who underwent VBG have had revision to RYGB for unsatisfactory weight loss.

Sixteen patients (14%) developed late complications after RYGB, including ten incisional hernias, three marginal ulcers, and three cases of small bowel obstruction. Small defects in the horizontal staple-line were later noted on upper gastrointestinal contrast studies in the patient who developed a subhepatic abscess and in two of the three patients with marginal ulcers. The three patients with bowel obstruction and two of the three patients with marginal ulcers required operative treatment.

Table 6. POSTOPERATIVE SWS AND MIC INTAKE

	SWS Intake		MIC Intake	
Time (mo)	VBG	RYGB	VBG	RYGB
6	18 ± 14	15 ± 16†	7 ± 10*	4 ± 8*†
12	14 ± 8	12 ± 13†	11 ± 14*	3 ± 6*†
18	22 ± 22	15 ± 17†	7 ± 9*	2 ± 4*†
24	15 ± 16	15 ± 17†	14 ± 14*	2 ± 5*†
36	15 ± 14	23 ± 21	15 ± 20*	1 ± 2*†

SWS = sweets/soda; MIC = milk and ice cream products; VBG = vertical banded gastroplasty; RYGB = Roux-en-Y gastric bypass.
SWS and MIC intake data expressed as mean ± SD of the percentage of total calorie intake.
* Significant difference between operations ($p \leq 0.003$ by Wilcoxon rank sum test).
† Significant difference between preoperative and postoperative intake ($p < 0.05$ by ANOVA with Duncan multiple range test).

The incidence of postprandial vomiting was significantly greater in patients who underwent VBG. All patients who underwent VBG reported vomiting at least once per month at their most recent follow-up visit, whereas 76% of the patients who underwent RYBG reported no emesis at their most recent visit ($p < 0.001$ by chi square test). However, nutritional deficiencies were noted only in patients who underwent RYGB. There were 30 cases of vitamin B-12 deficiency, 2 cases of folate deficiency, and 30 cases of iron deficiency, including 14 with concomitant anemia. There were three other cases of borderline anemia that were not associated with vitamin or mineral deficiencies. All of these nutritional deficiencies were treated on an outpatient basis. Two patients with severe iron deficiency anemia (Hb < 10 g) were treated with iron (Imferon, Fisons Consumer Health, Rochester, NY) injections. The remaining patients were treated with oral supplements.

DISCUSSION

In 1982, Mason introduced VBG and touted that this procedure would "be the end of the evolutionary line for gastric reduction as treatment for morbid obesity."[12,13] Because the alimentary tract remains intact, weight loss after VBG results entirely from restriction of calorie intake. The relative technical simplicity and lack of inherent metabolic complications have made VBG the most commonly performed bariatric operation in the United States during the past decade.[14] Roux-en-Y gastric bypass is a more technically difficult operation than VBG. Because nearly all of the stomach and the entire duodenum are excluded from digestive continuity, there are several potentially serious metabolic sequelae associated with RYGB.[15-17] However, because malabsorption of ingested protein, carbohydrates, and fat has not been reported in clinical or laboratory studies of conventional gastric bypass operations, weight loss after RYGB also is the result of restricted calorie intake.

Comparison of Weight Loss and Complications

After noting significantly greater weight loss in patients who underwent RYGB *versus* patients who underwent VBG in a prospective randomized clinical trial, Sugerman's group retrospectively analyzed preoperative eating behavior in the study patients. This analysis disclosed that "nonsweets eaters" had significantly greater weight loss than "sweets eaters" after VBG.[5] Conversely, there was no difference in weight loss between sweets eaters and nonsweets eaters after RYGB. On the basis of these findings, Sugerman began to selectively assign prospective patients who were sweets eaters to RYGB, whereas nonsweets eaters were recommended to have VBG. This practice resulted in significantly better weight loss among patients who had VBG and no decline in weight loss among patients who had RYGB.[18] However, only 18% of patients who were evaluated using these criteria qualified as candidates for VBG. Likewise, only 22% of the 138 patients in the current series were selected for VBG on the basis of their preoperative eating habits.

Loss of 50% of the excess weight is defined as the minimum criterion for successful weight loss in several previous reports of bariatric operations.[11,19-21] In the current series, only 40% of patients who had VBG lost ≥ 50% of their excess weight, whereas 92% of the patients who had RYGB lost this much weight. This difference represents a greater disparity in weight loss outcome between VBG and RYGB than has been reported by other investigators.[5,7,20] The superior weight loss after RYGB probably also was responsible for the significantly greater incidence of improvement or resolution of obesity-related comorbidities in patients who underwent RYGB *versus* patients who underwent VBG (Table 2). Obesity-related medical problems generally were controlled for as long as satisfactory weight loss was maintained. We were somewhat surprised at the high incidence of success in the RYGB group. Exclusion of super obese patients from this study probably contributed to these favorable results. However, late weight gain was noted after both procedures. Regaining of lost weight generally occurred during the third postoperative year after VBG and during the fourth year after RYGB (Fig. 3). In the RYGB group, regain of more than 10% of lost weight occurred almost invariably in patients with a preoperative body mass index ≥ 45. Conversely, there was no correlation between late weight gain and preoperative weight in patients who underwent VBG.

Late staple-line disruption was not a prominent cause of unsatisfactory weight loss in the current series. Although our patients were not evaluated routinely for late staple-line breakdown, repeat upper gastrointestinal contrast studies were performed in all of the patients who had revision of their primary gastric restrictive operation and in 19 other patients who either had unsatisfactory weight loss or regained a portion of their lost weight. Disruption of the stapled gastric partition was recognized in only four patients, two of whom have maintained satisfactory long-term weight loss.

Table 7. POSTOPERATIVE HCL AND NLS INTAKE

	HCL Intake		NLS Intake	
Time (mo)	VBG	RYGB	VBG	RYGB
6	43 ± 30*	24 ± 31*	16 ± 26*	9 ± 22*†
12	31 ± 27*	16 ± 29*†	19 ± 26*	13 ± 23*†
18	18 ± 29	19 ± 32†	33 ± 41*	13 ± 23*†
24	15 ± 19	18 ± 27†	25 ± 29	15 ± 25†
36	11 ± 31	26 ± 35	27 ± 38	17 ± 27†

HCL = high caloric liquids; NLS = nonliquid sweets; VBG = vertical banded gastroplasty; RYGB = Roux-en-Y gastric bypass.
HCL and NLS data expressed as mean ± SD of the percentage of sugar in the diet.
* Significant difference between operations ($p \leq 0.004$ by Wilcoxon rank sum test).
† Significant difference between preoperative and postoperative intake ($p < 0.05$ by ANOVA with Duncan multiple range test).

Comparison of Eating Patterns

In the absence of staple-line disruption, excessive calorie intake is the primary cause of poor weight loss after gastric restrictive operations. Because the initial gastric pouch volume and stoma size of VBG and RYGB are nearly identical, the disparity in weight loss between the two procedures is likely caused by differences in postoperative eating behavior. Sugerman and others have postulated that patients who undergo RYGB consciously avoid eating sweets for fear of developing unpleasant symptoms associated with the dumping syndrome.[4-6] In the current report, consumption of SWS, HCL, and NLS during the first 24 months after RYGB decreased significantly *versus* preoperative levels. Conversely, intake of SWS remained unchanged after VBG. A gradual increase in postoperative tolerance for sweets after RYGB is the likely explanation for the lack of statistically significant differences in HCL and NLS intake between the two groups after 18 months postoperatively.

Lactose intolerance has been reported in 30% to 40% of patients who have gastric resection performed for either peptic ulcer disease or malignancy.[22-24] In the current study, there was a remarkable disparity in postoperative MIC intake between patients who had VBG and patients who had RYGB (Table 6). Postoperative consumption of MIC decreased significantly *versus* preoperative levels in patients who had RYGB, whereas MIC intake gradually increased over time after VBG. Many patients who underwent RYGB reported various combinations of nausea, vomiting, diarrhea, and abdominal pain after ingestion of milk products, especially ice cream. Other patients who underwent RYGB described "losing their taste" for MIC without having unpleasant gastrointestinal symptoms. In patients who had RYGB, the aversion to milk products was more pronounced and prolonged than the aversion to sweets.

After 6 months postoperatively, vomiting was only problematic in the VBG group. In fact, all of our patients who underwent VBG reported occasional vomiting after eating solid food. Fear of vomiting appeared to have a major impact on postoperative food preferences after VBG. Many patients who had VBG reported a marked increase in consumption of sweets and ice cream postoperatively because they were easier to swallow than other solid foods. Ice cream was the most frequently abused food after VBG. The majority of patients who had VBG could not eat meat. Conversely, after RYGB, gradual enlargement of the stoma probably is responsible for both the abatement of postprandial vomiting and the eventual tolerance of a balanced diet that includes meat, fresh fruit, and vegetables.

In the current study, maladaptive eating behavior also was the primary reason for excessive calorie intake and inadequate weight loss after RYGB. Many patients who underwent RYGB could drink large quantities of sweet HCL without unpleasant side effects. In fact, more than half of our patients who underwent RYGB and lost less than 50% of their excess weight were HCL abusers. This finding suggests that post-RYGB dumping symptoms typically occur after ingestion of sweet solids rather than sweet liquids. High calorie salty snack foods, which generally do not produce much satiety, were the most commonly abused solids after RYGB. Patients who successfully avoided sweets, ice cream, and salty junk foods almost invariably had satisfactory maintenance of weight loss after both operations.

The 1-day dietary recall that was employed in this study provides a reasonably accurate assessment of nutrient intake in the outpatient setting.[25] Premeasured cups and food models were used in the 1-day recall to minimize discrepancy among patients in reporting quantities of food and beverages consumed. We have compared the 1-day recall method with a 1-week food frequency questionnaire in 65 bariatric surgical patients and found statistically significant correlations in intake of total calories, MIC, SWS, and NLS between the two recall methods.[26] The significant correlations between these two methodologies strengthen the validity of the dietary data in the current study. Moreover, the significantly greater preoperative consumption of carbohydrates and SWS in the RYGB group suggests that this methodology can be used to identify "sweets eaters" in a population of severely obese patients. The post hoc comparison of daily meals and snacks in the two groups confirmed that snackers were appropriately assigned to have RYGB.

However, there are potential sources of inaccuracy with this methodology. Although the computer software (Nutritionist III) used in this study was sufficient to evaluate total calorie intake, percentage dietary composition of protein, carbohydrates, and fat, and SWS and MIC items individually as a percentage of total calories in the diet, the program only measured relative changes in dietary composition. Hence, it could not place specific foods into specific categories. This was done manually. Although preoperative calorie intake was substantially greater in patients who had VBG, the mean preoperative body mass index was nearly identical in the two groups. Underestimation of calories consumed from snacks in patients who had RYGB provides a plausible explanation for this discrepancy. The primary sources of methodologic inaccuracy in the current study probably are related to both discrepancies in patient diet reporting and the inherent limitations of the 1-day dietary recall.

The superior weight loss observed after RYGB in this and other studies is probably a result of substantial differences in postoperative food preferences between gastroplasty and gastric bypass patients. The primary advantage of RYGB over VBG appears to be the unpleasant symptoms produced by consumption of milk products and sweets after gastric bypass, which results in postoperative avoidance of these foods. Conversely, a substantial number of patients who underwent VBG became sweets and ice cream eaters postoperatively because they could not comfortably consume even small quantities of meat, vegetables, and fruit. Although patients in this study were selected for VBG on the basis of eating habits that were well suited for any type of gastric restrictive operation, these results suggest that preoperative evaluation of eating behavior does not consistently result in satisfactory weight loss after VBG. The superior long-term weight loss, coupled with a lower incidence of serious late complications, clearly favor RYGB in the treatment of morbid obesity. On the basis of this study, we no longer recommend VBG as primary treatment for patients with morbid obesity.

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